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DRAFT MEMORANDUM

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TO: Chris Cosentini
FROM: Peter Cox
Mark Westray
DATE: December 14, 2005

CLIENT: Dave Smith, BNSF
TASK: Somers, MT - TI

RE: Evaluation of Natural Attenuation Rates

Overview

Recent evaluation of groundwater data from the current treatment system at the site indicates that full aquifer restoration as defined in the ROD cannot be achieved in a reasonable timeframe. After six years of operation, the groundwater treatment system has removed only 2% of the estimated DNAPL contamination in the site aquifer. Modeling results estimate that it will take at least 1,700 years of operation to restore the aquifer to drinking water quality. These findings and recommendations for the technical impracticability for groundwater restoration were presented to EPA in April 2003 in the document, *Technical Impracticability Evaluation for Groundwater Restoration, Former Somers Tie Treating Plant, Somers, Montana* (RETEC, 2003). This memo presents an approach to evaluate the assimilative capacity of the aquifer to naturally degrade dissolved phase constituents in groundwater. This capacity can then be compared with removal estimates from the groundwater treatment system.

Evaluation Approach

In order to evaluate the natural biodegradation of the dissolved hydrocarbon plume at the site, calculations will be performed to estimate the rate of naphthalene biodegradation occurring under ambient conditions. This evaluation will be undertaken using the screening methodology described in EPA's document, *BIOSCREEN Natural Attenuation Decision Support System, User's Manual Version 1.3* (Newell, C.J. et al, 1996). For this evaluation, both aerobic and anaerobic biodegradation processes will be simulated as "instantaneous" reactions that are limited by the availability of electron acceptors. This assumption is usually valid in groundwater systems since the microbial reactions occur at much faster rates then the time required for the aquifer to replenish the electron acceptors. This assumption is considered valid for the Somers site since the average linear velocity of groundwater is only approximately 0.007 feet per day (assuming an average hydraulic conductivity of 0.35 ft/day, and a maximum hydraulic gradient of 0.005 ft/ft, and a porosity of 0.25). Another simplification of this method is that it lumps all biodegradation reactions together; that is, it assumes that all of the various aerobic and anaerobic reactions occur over the entire plume. This assumption is also valid at most sites due to hydrogeologic heterogeneity and the existence of biogeochemical "microenvironments" within dissolved contaminant plumes. The effects of this simplification are discussed in Newell et al (1996).

The electron acceptor limited instantaneous model is applied by calculating the amount of biodegradation able to be supported by the flow of groundwater and flux of electron acceptors through the source zone. The approach to this calculation includes:

- Estimating the total amount of available electron acceptors by calculating the difference between upgradient and source-zone concentrations of oxygen, nitrate, and sulfate and measuring the production of the metabolic by-products ferrous iron and methane in the source zone

- Developing a contaminant utilization factor based on the stoichiometric ratio for the reaction of electron acceptors (oxygen, nitrate, and sulfate) with representative dissolved organic constituents

- Developing a contaminant utilization factor based on the stoichiometric ratio for the production of metabolic by-products (ferrous iron and methane) resulting from biodegradation reactions

Required Input Data

Concentrations of electron acceptors and metabolic by-products from site groundwater data are necessary for this evaluation. Data input from upgradient concentrations and concentrations within the plume are needed. Utilization of electron acceptors (oxygen, nitrate, and sulfate), or production of metabolic by-products (ferrous iron and methane) will be based on the difference between the upgradient and in-plume concentrations of these parameters. Other data required for the calculation include the width of the site, the aquifer thickness, and the average hydraulic conductivity and hydraulic gradient for the site.

Using the parameter concentrations, the site-specific hydrogeologic parameters, and the stoichiometric utilization factors provided in Newell et al. (1996) converted for naphthalene, the data will be input into the attached spreadsheet (Table 1) and the total naphthalene assimilative capacity under ambient conditions can be estimated for the site. The results can then be compared to the removal estimates from the groundwater treatment system to evaluate the effectiveness of natural biodegradation as a groundwater remedy for the site in the absence of active groundwater extraction and treatment.

Available Data

The data needs described above are not available from the existing groundwater dataset for the site. Due to the operation of the groundwater extraction system and re-injection of oxygenated water existing dissolved oxygen data is concentrated in the areas of active operations and not representative of ambient conditions.

Table 1
Biodegradation Capacity Evaluation
Former Somers Tie Treating Plant
Somers, Montana

Aquifer Data	Oxygen Flux	Nitrate Flux	Ferrous Iron Flux	Sulfate Flux	Methane Flux	
Width of Site (ft)	600 ft					
Aquifer Thickness (ft)	50 ft					
Hydraulic Conductivity (K) (ft/d)	0.35 ft/d					
Gradient (i) (ft/ft)	0.005					
Upgradient Oxygen Conc. (mg/L)	0 mg/L	delta NO_3 0 mg/L	delta Fe+2 0 mg/L	delta SO_4 0 mg/L	delta CH_4 0 mg/L	
Upgradient Oxygen Conc. (mg/m^3)	0 mg/m^3	0 mg/m^3	0 mg/m^3	0 mg/m^3	0 mg/m^3	
Q=KiA (ft^3/d)	52.5 ft^3/d					
Q=KiA (m^3/d)	1.49 m^3/d					
Flux of Oxygen [upgradient or delta * Q (in m^3/d)]	0 mg/d	NO_3 Flux 0 mg/d	Fe+2 Flux 0 mg/d	SO_4 Flux 0 mg/d	CH_4 Flux 0 mg/d	
Biodegradation Assimilative Capacity [Flux/utilization factor]	0 mg/d	0 mg/d	0 mg/d	0 mg/d	0 mg/d	
Ambient Naphthalene Biodegradation Capacity (mg/d)	0 mg/d	0 mg/d	0 mg/d	0 mg/d	0 mg/d	**Total Assimilative Capacity** **0 mg/d**

site specific data needs

Notes:

Naphthalene Utilization Factors*	mg/L	mg/m^3
Oxygen	3.00	3,000
Nitrate	4.68	4,680
Ferrous Iron	20.8	20,820
Sulfate	4.49	4,490
Methane	0.74	740

* = Based on BTEX utilization factor (from BIOSCREEN) corrected for naphthalene by multiplying by 0.955 (or 95.5% of the BTEX utilization factor)

5/4/2007

NOTICE

This item(s) is not suitable for microfilming, but is available for review at the Environmental Protection Agency, Region VIII Superfund Records Center, Helena, Montana

TITLE: (COMMENTS ON EVALUATION OF NATURAL ATTENUATION RATES)

DATE: DEC. 14, 2005

ITEM DESCRIPTION: FIGURE 1-1 SITE PROPERTY BOUNDARY MAP BNSF SOMERS, MT

FILE: 11.5 DOCNO: 491174

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